The role of a priori information in gravity field determination

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G4.2: Satellite Gravimetry: GRACE, GOCE and Future Gravity Missions

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Contents

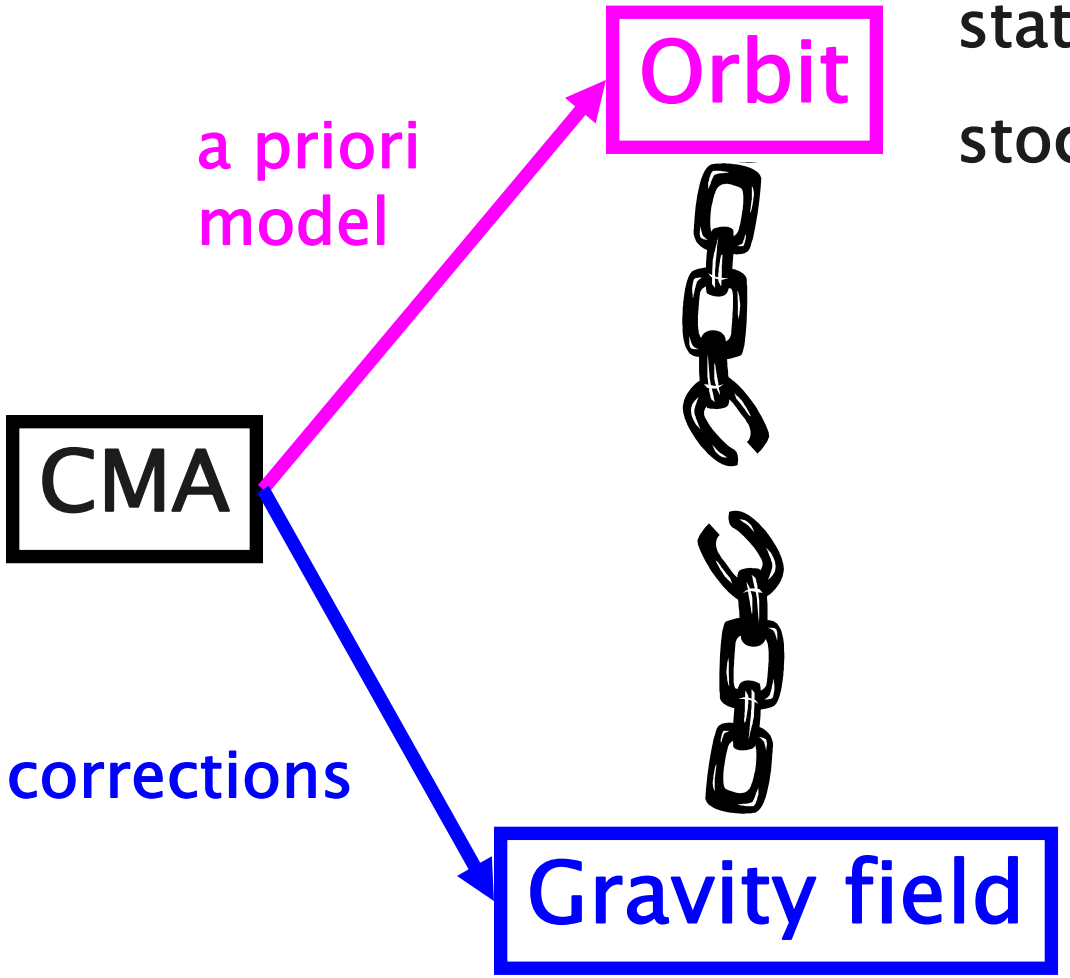
- Gravity field, Orbit, and the Celestial Mechanics Approach
- Signal and Noise in monthly fields (GRACE)
- Separation of Orbit and Gravity field estimation
- How does it work?
- Discussion

Gravity field and Orbit

Non-linear parameter estimation problem

- A priori model (linearization)
- Observations
- Regularization (a priori knowledge via pseudo-observations)

The Celestial Mechanics Approach (CMA)

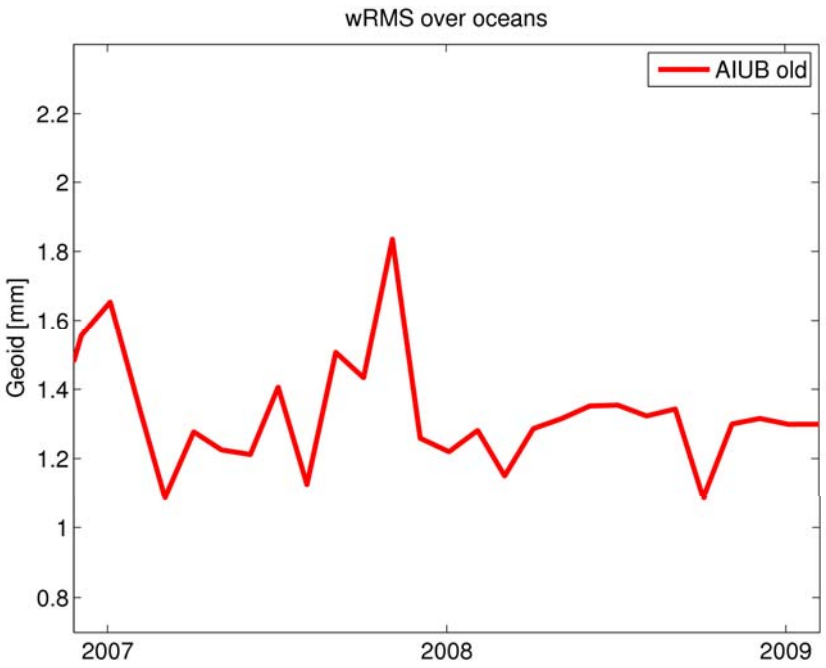


state vector

stochastic parameters

spherical harmonic coefficients

Signal and Noise in monthly fields (GRACE)



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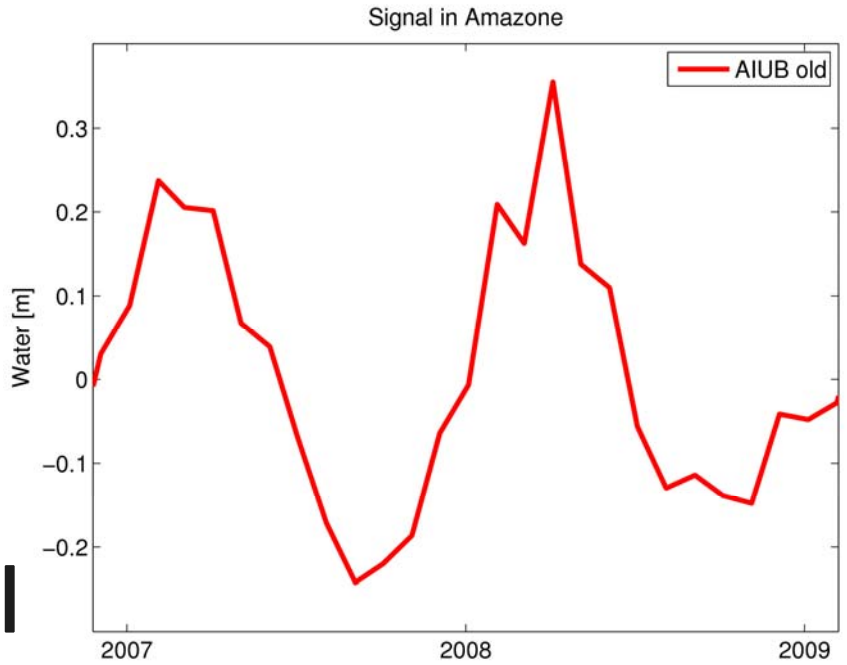
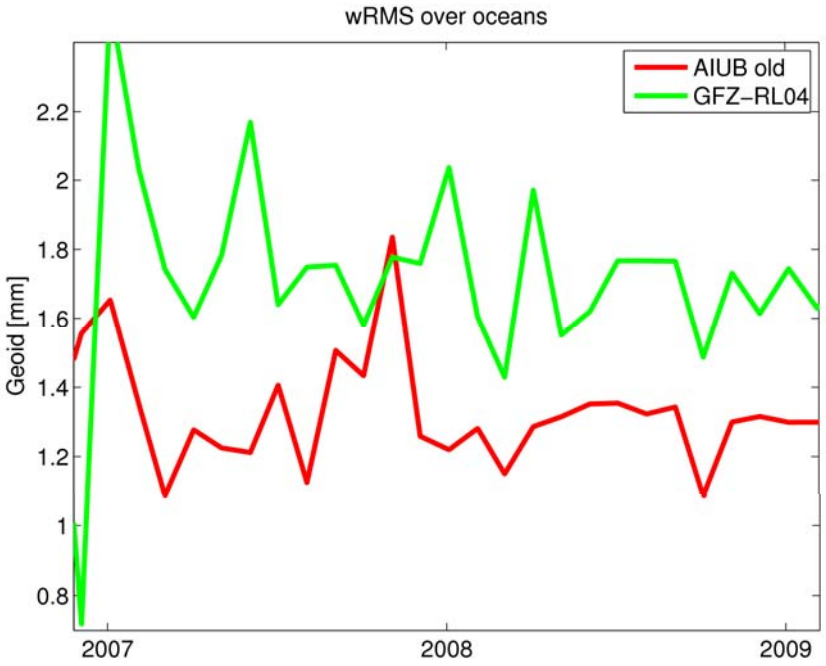


signal

Signal and Noise in monthly fields (GRACE)



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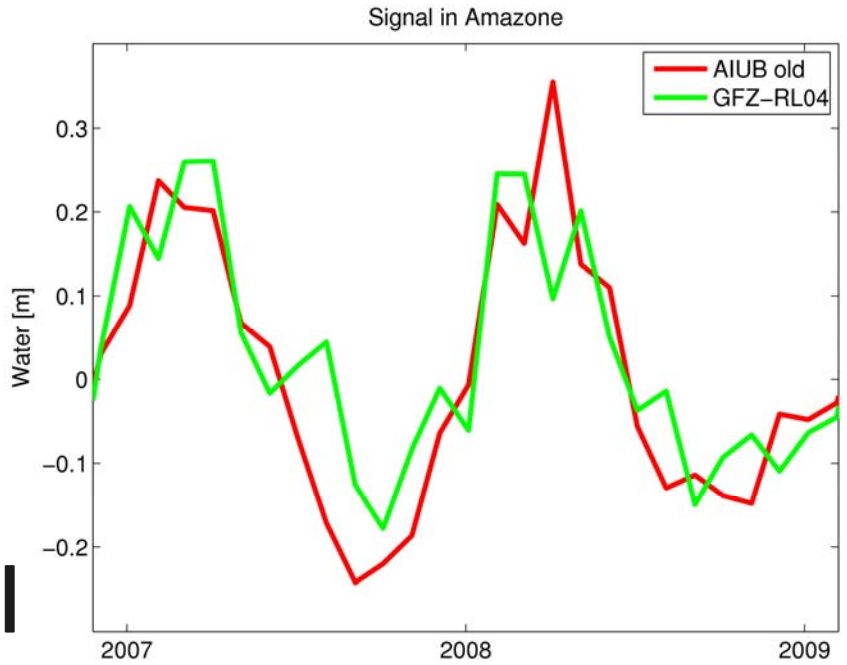

signal

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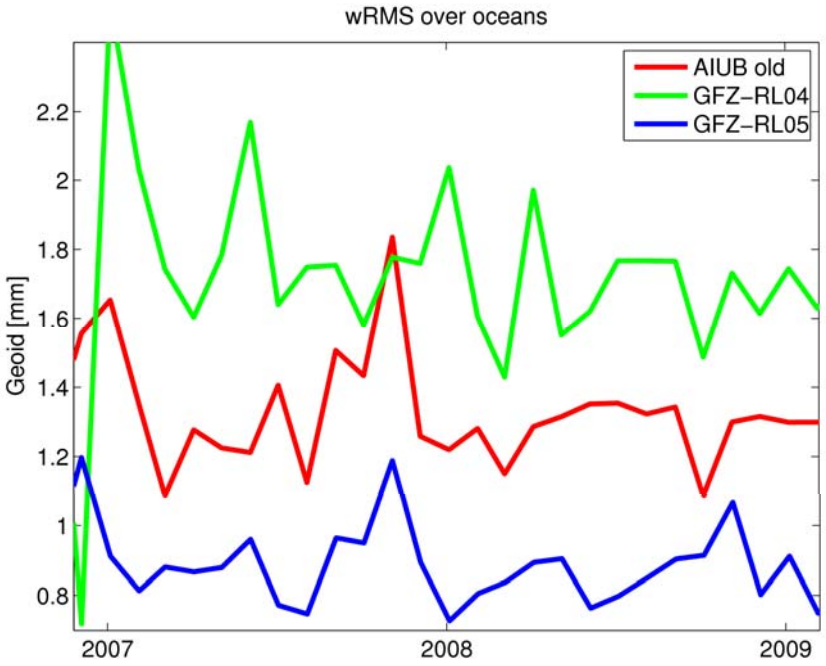

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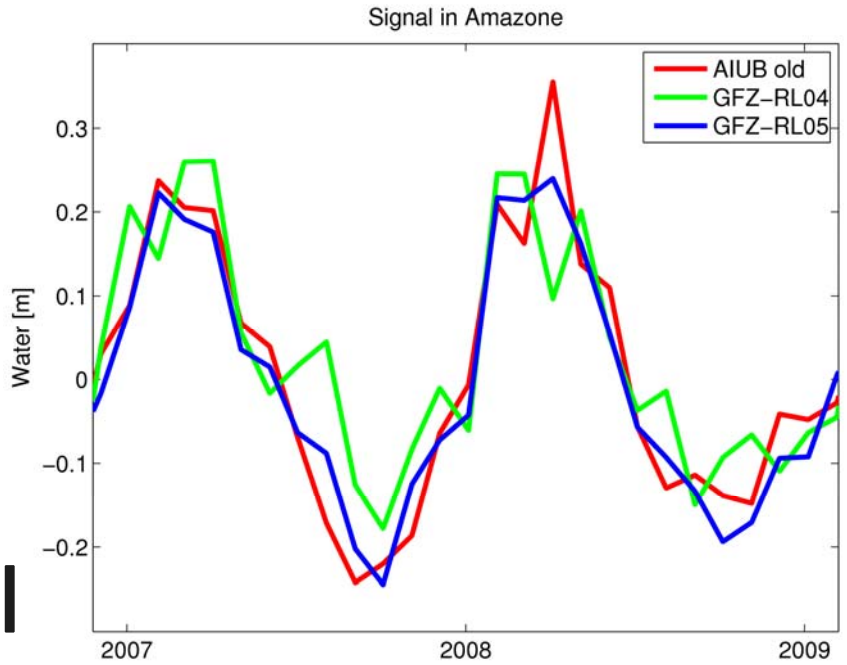

signal

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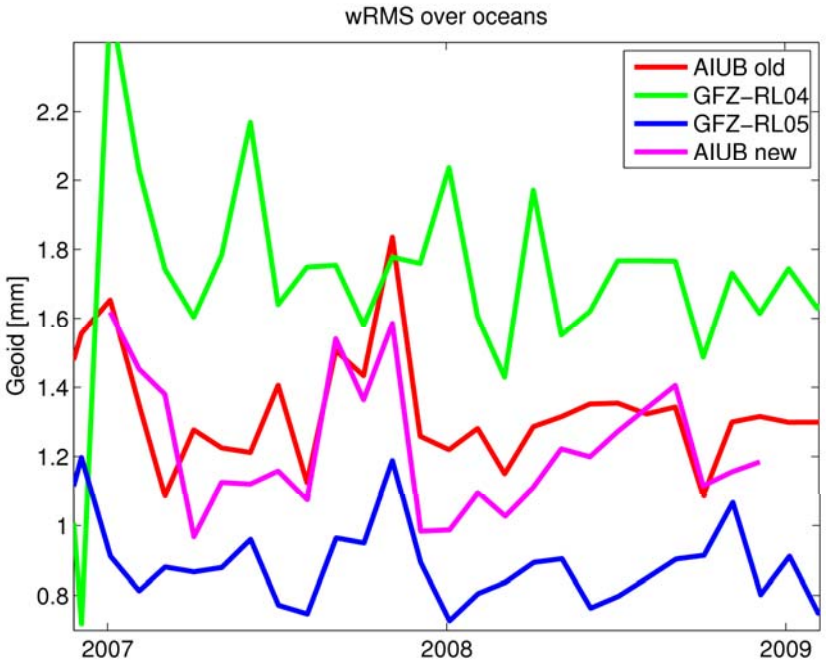

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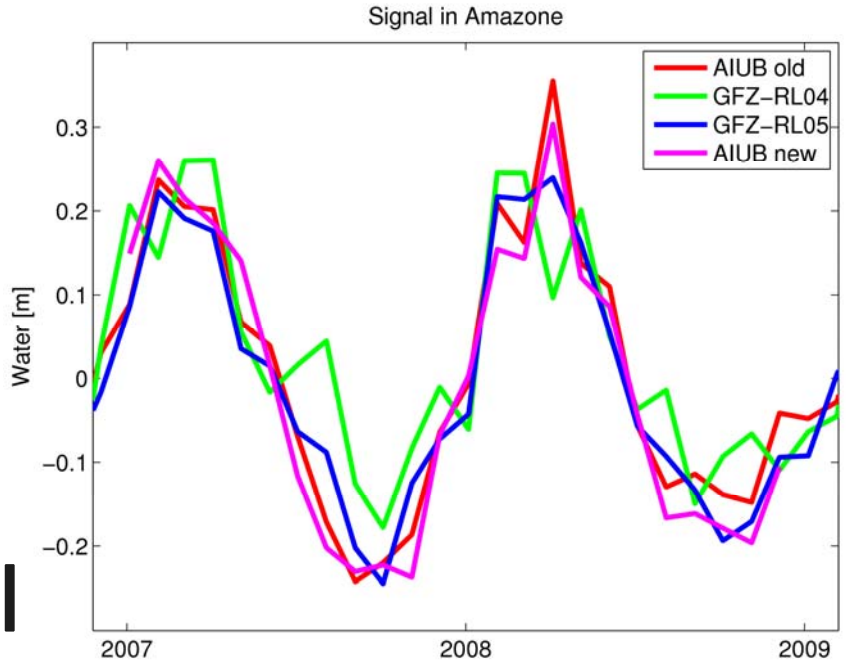

signal

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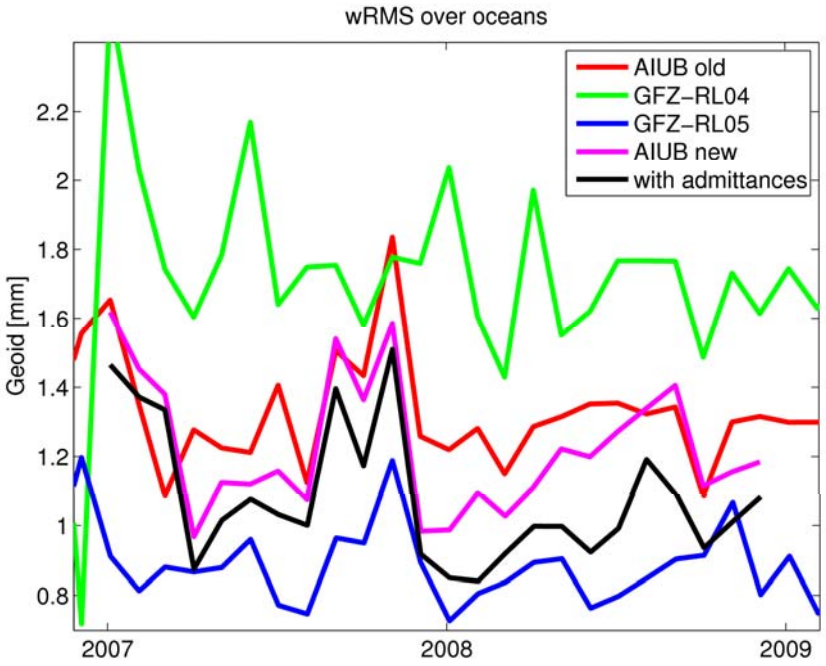

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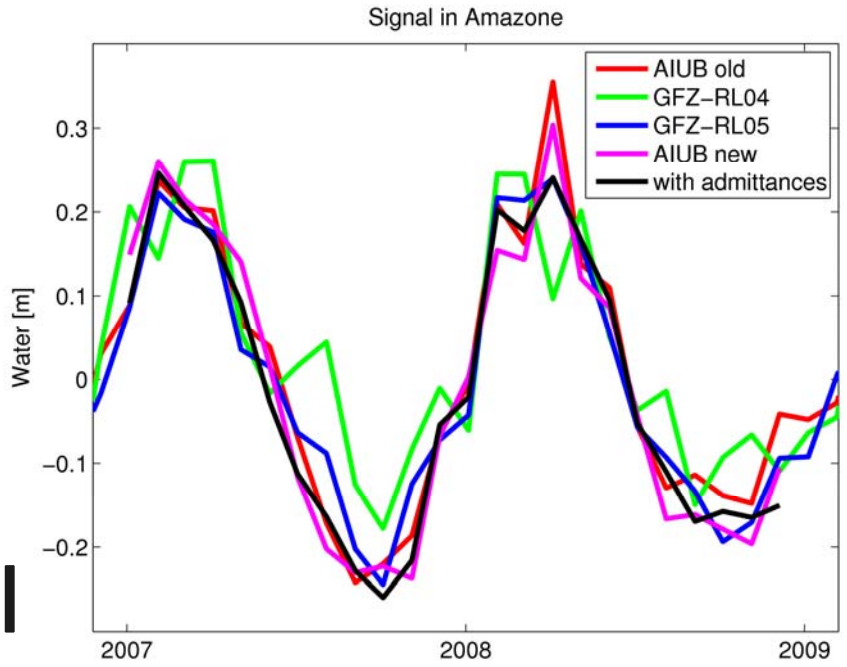
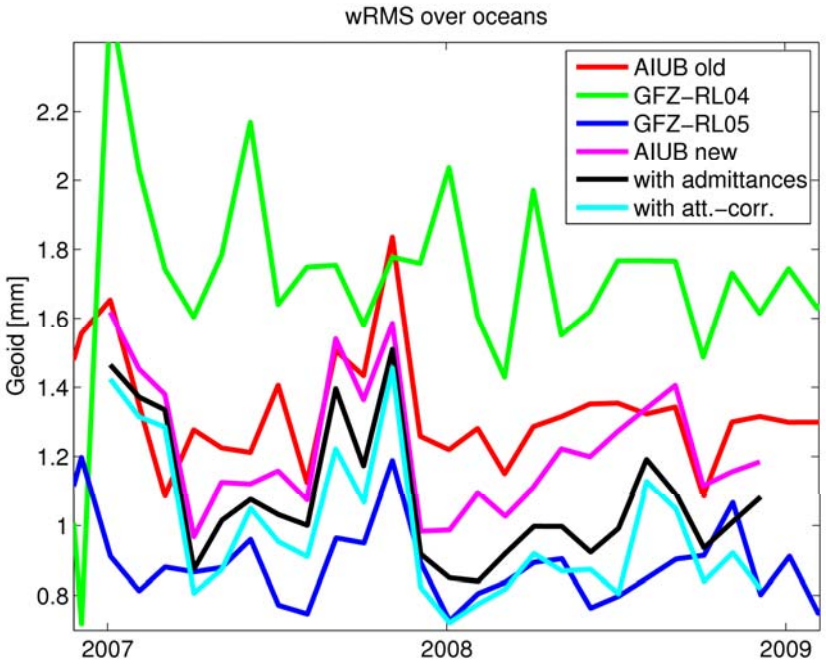


signal

Signal and Noise in monthly fields (GRACE)



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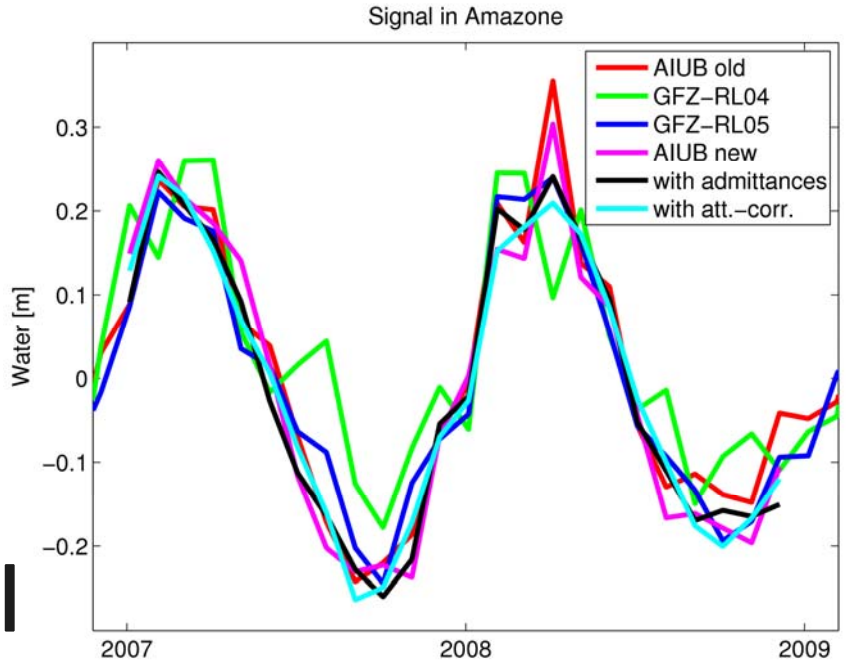
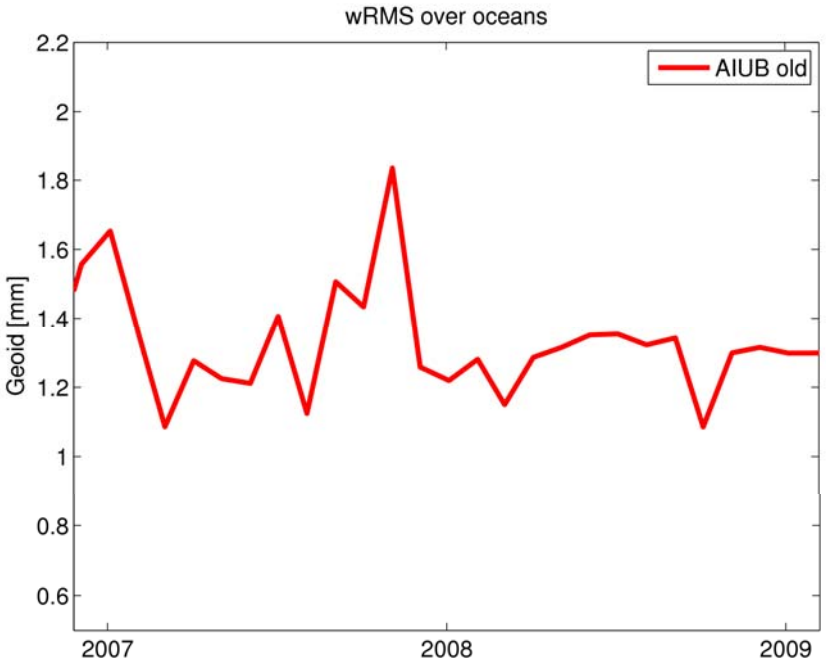


signal

NEQ-modification tools

- Sampling / Binning of stochastic parameters.
- Absolute / Relative constraining of stochastic parameters.
- Pre-Elimination of arc-specific parameters (correlations with SH coefficients are kept).
- Deletion of arc specific parameters (correlations with SH coefficients are destroyed).

Separation of Orbit and Gravity field



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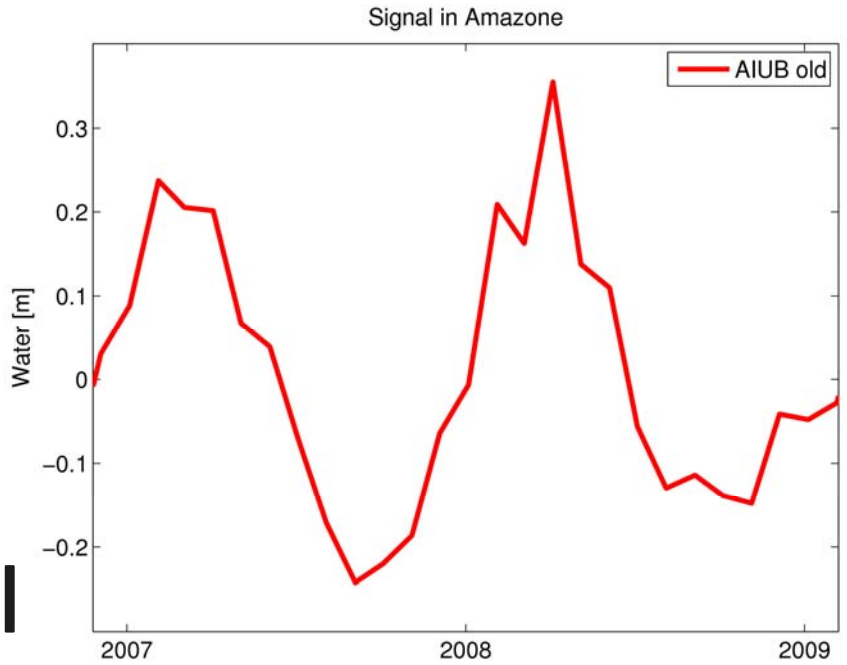
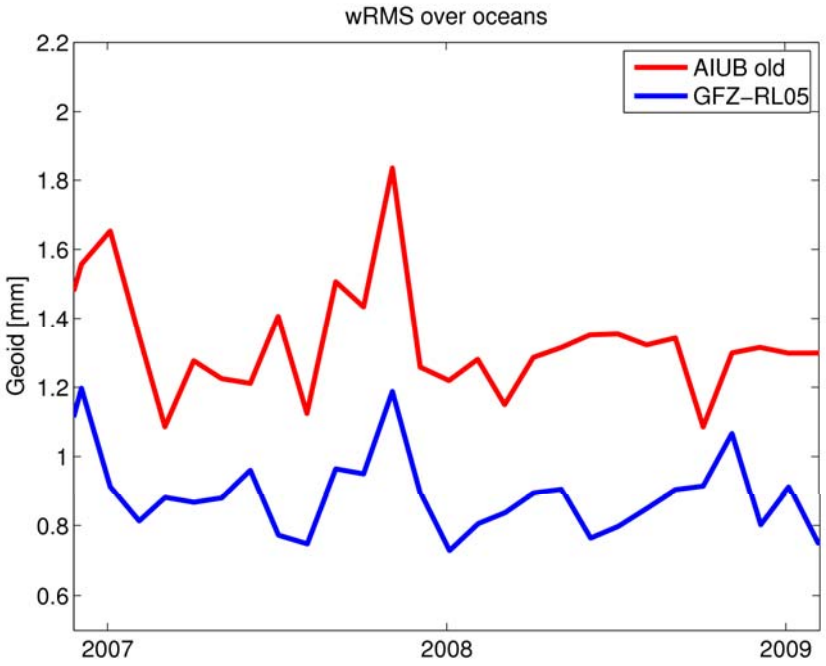


signal

Separation of Orbit and Gravity field



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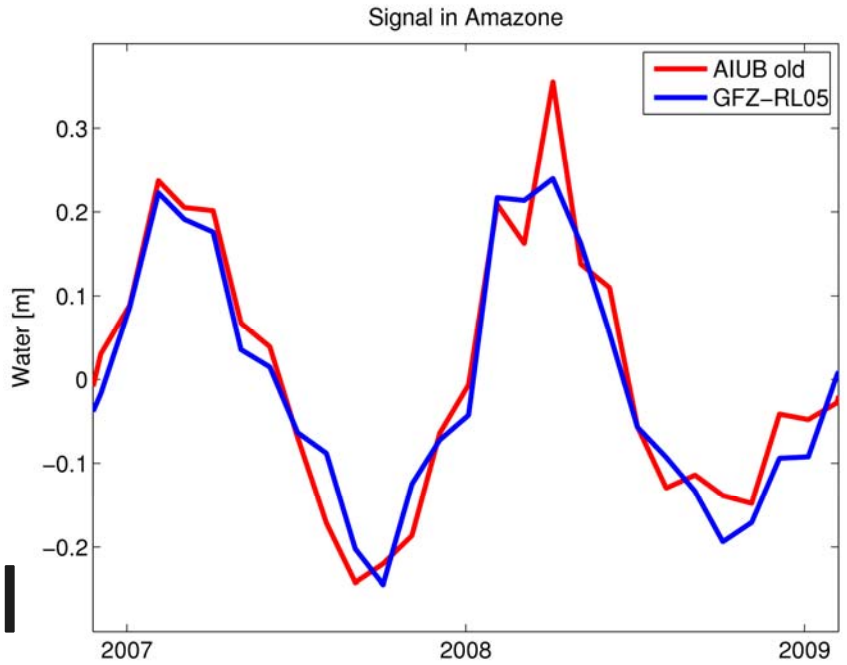
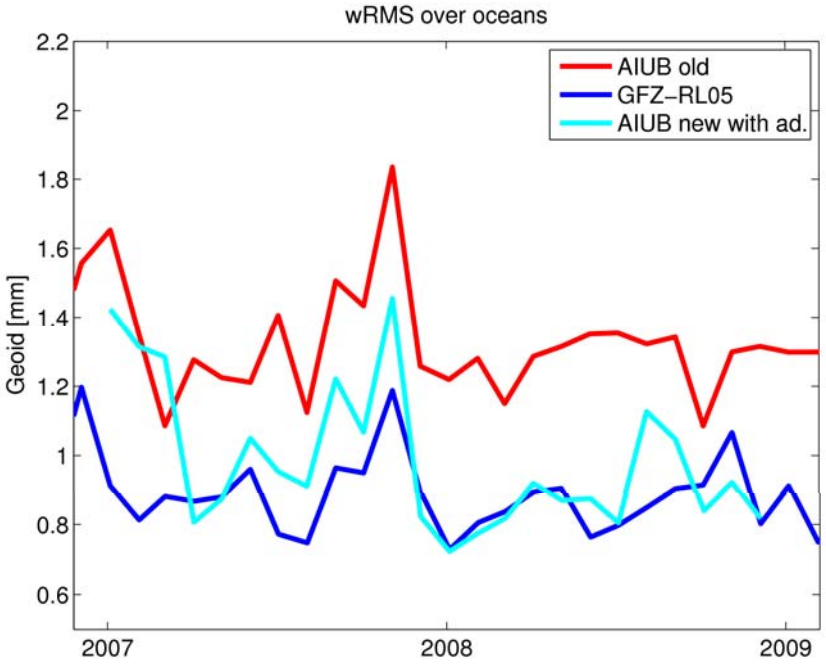


signal

Separation of Orbit and Gravity field



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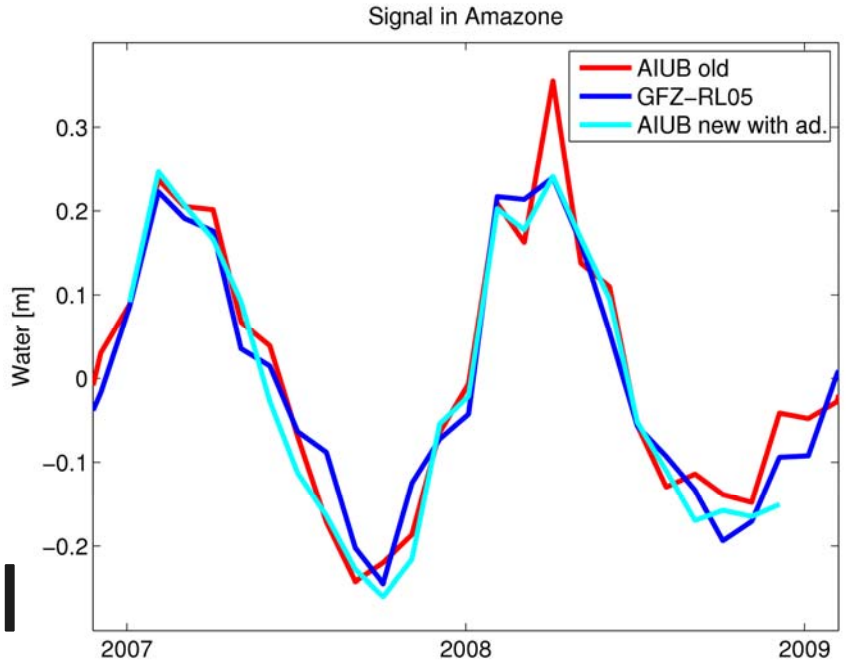
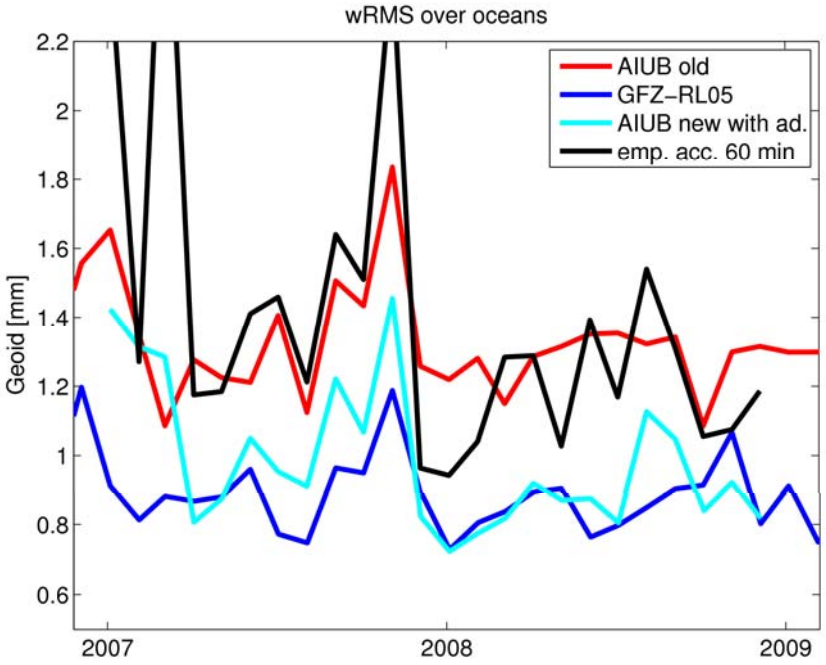


signal

Separation of Orbit and Gravity field



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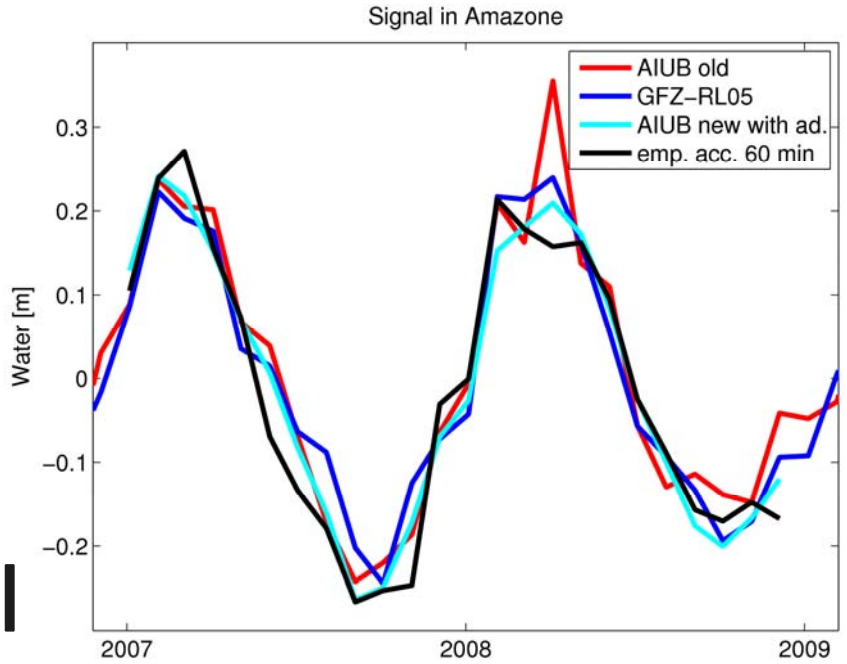
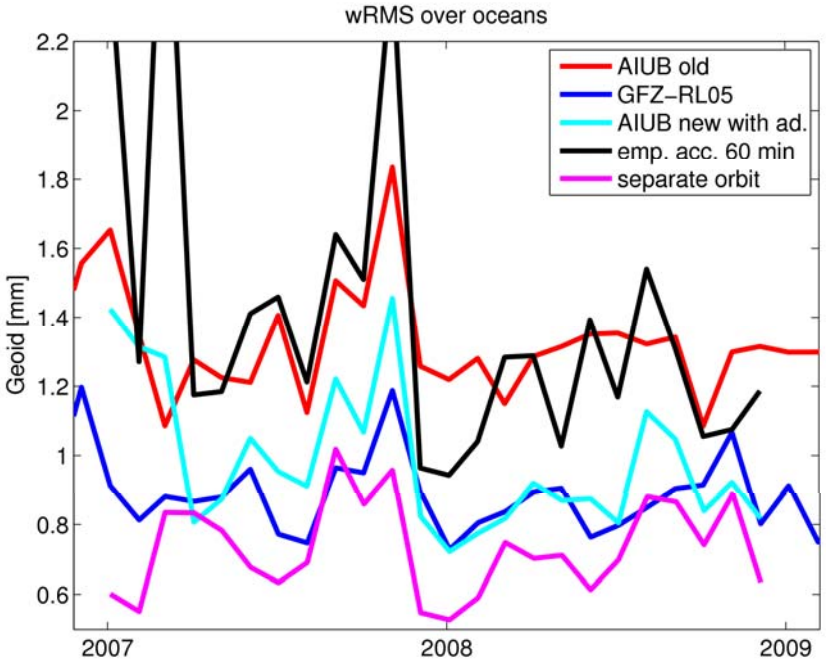


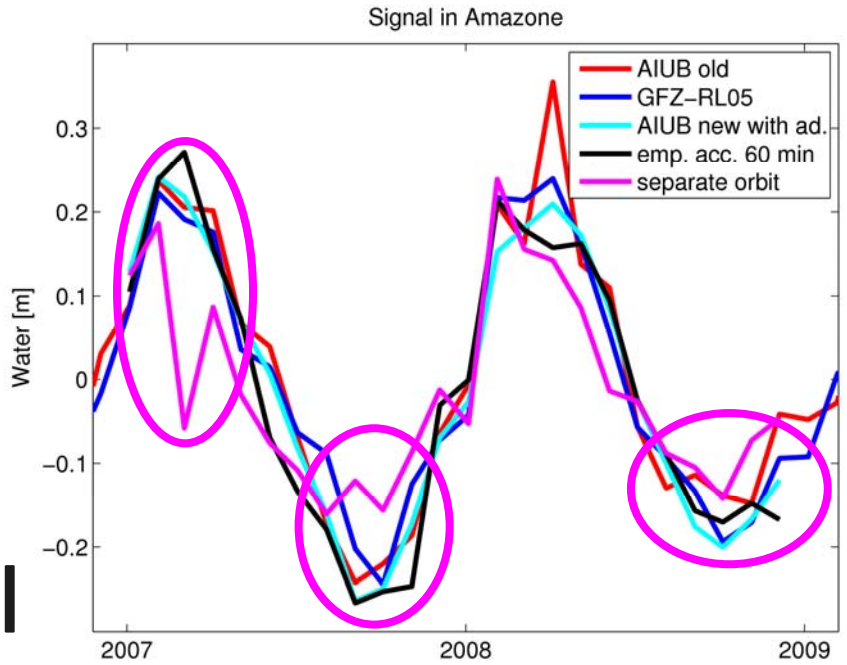
signal

Separation of Orbit and Gravity field



noise

signal loss



signal

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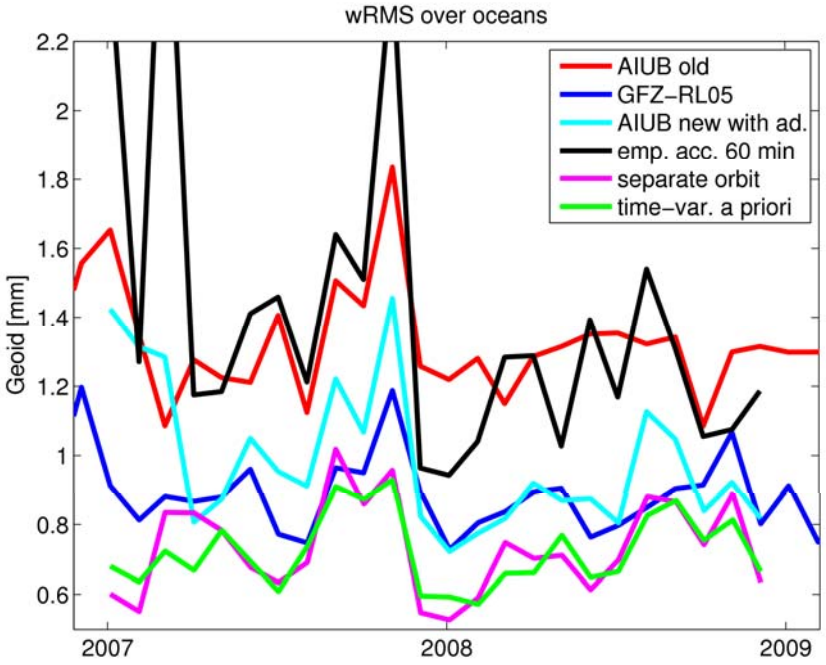

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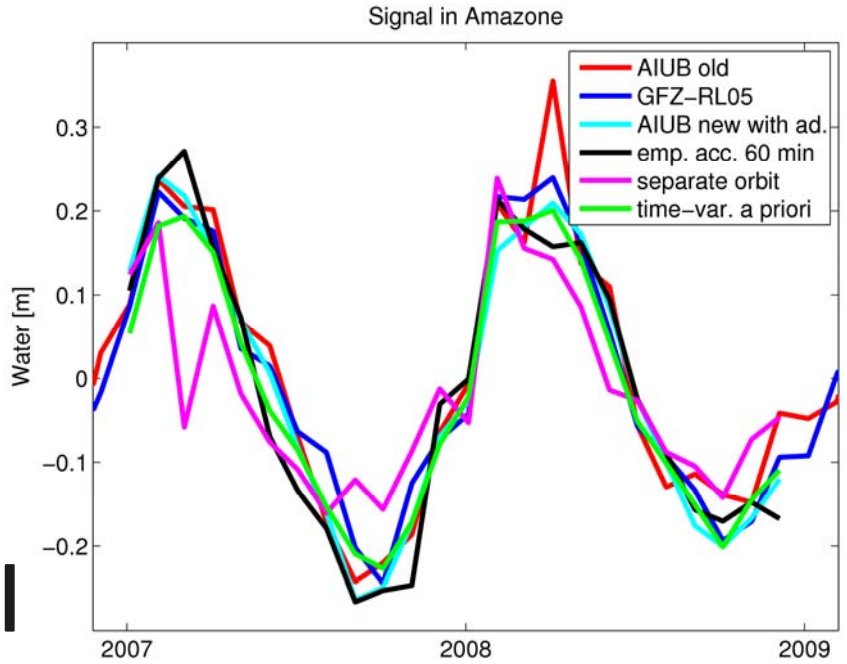

signal

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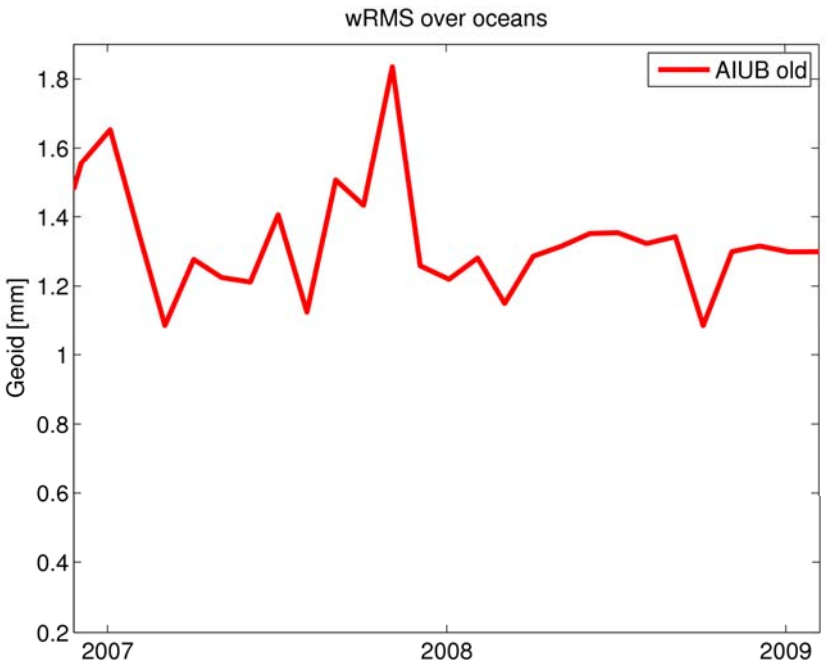

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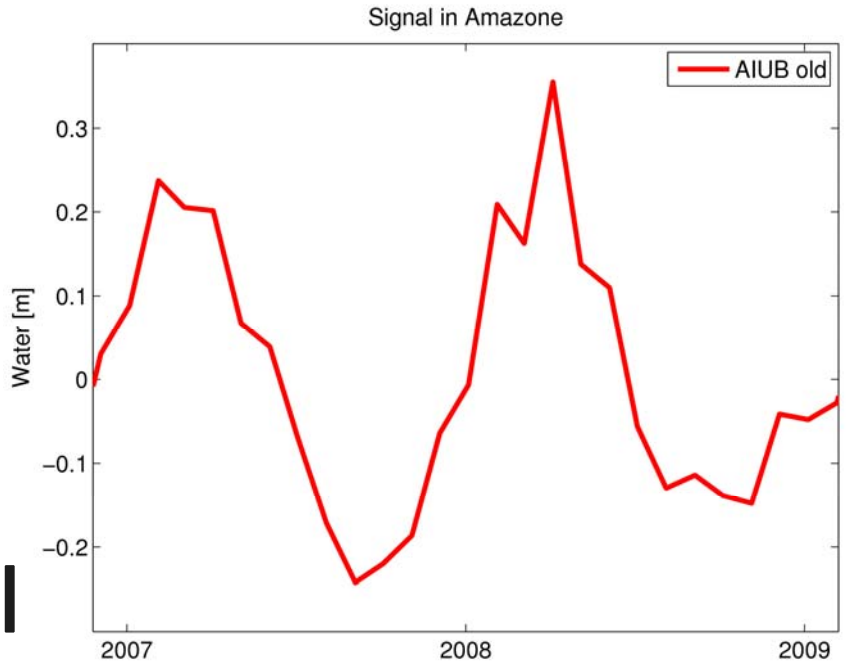

signal

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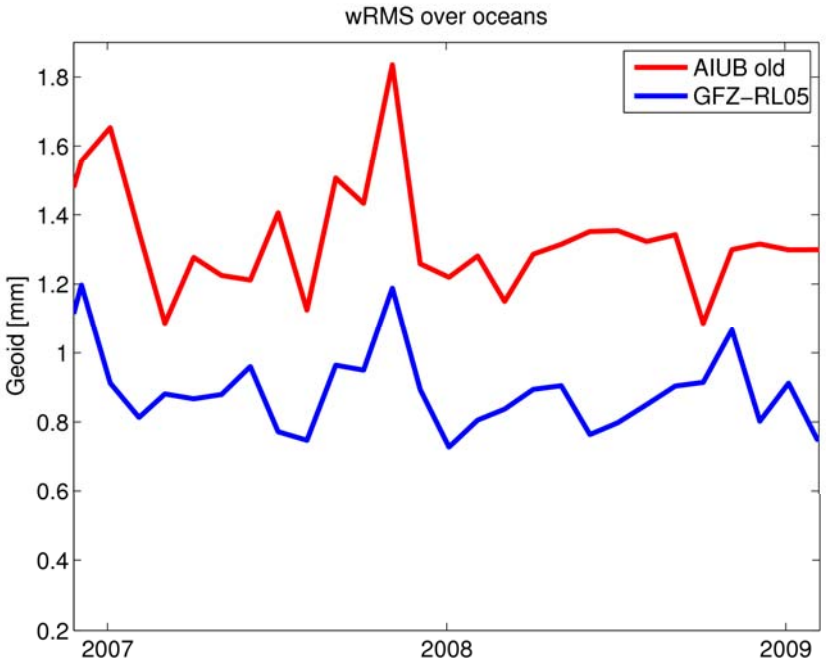

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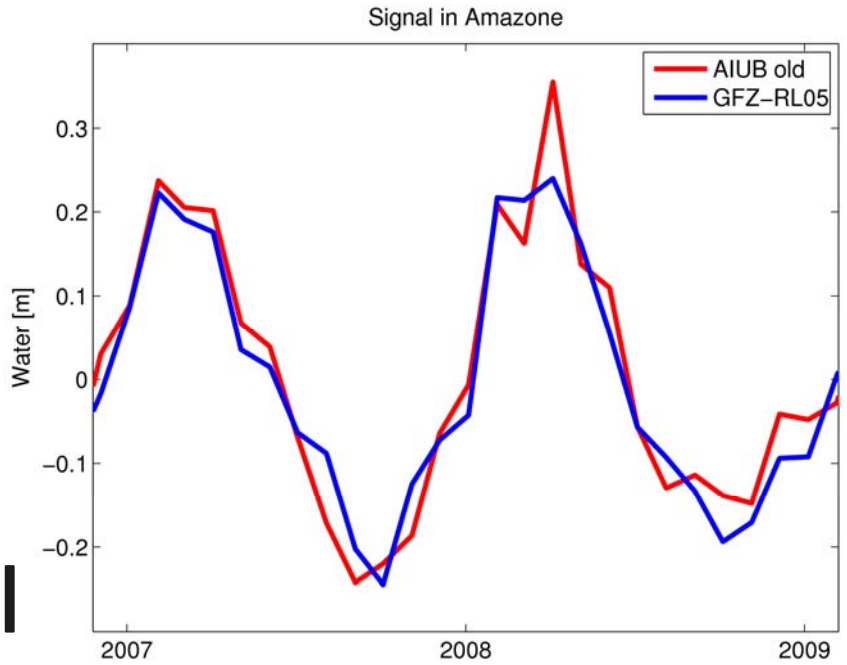

signal

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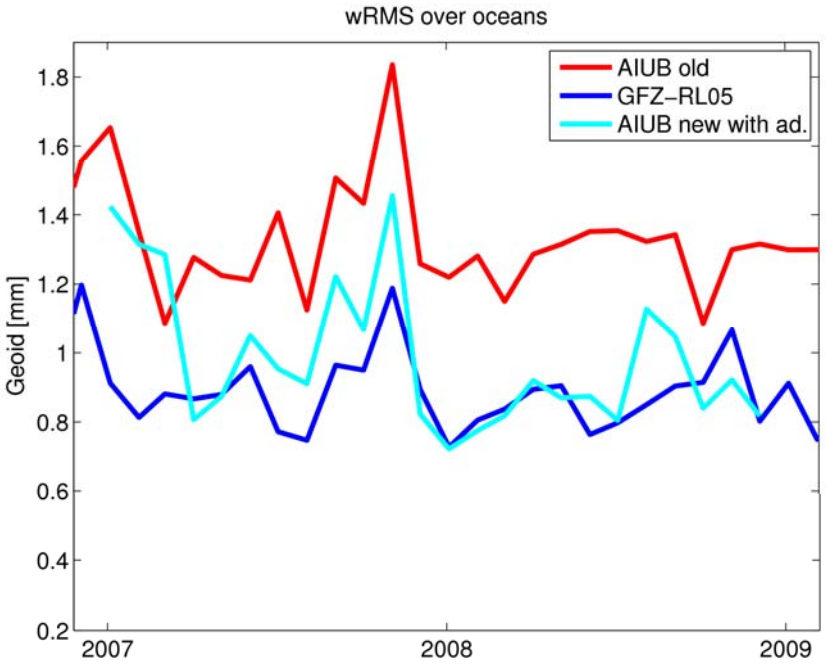

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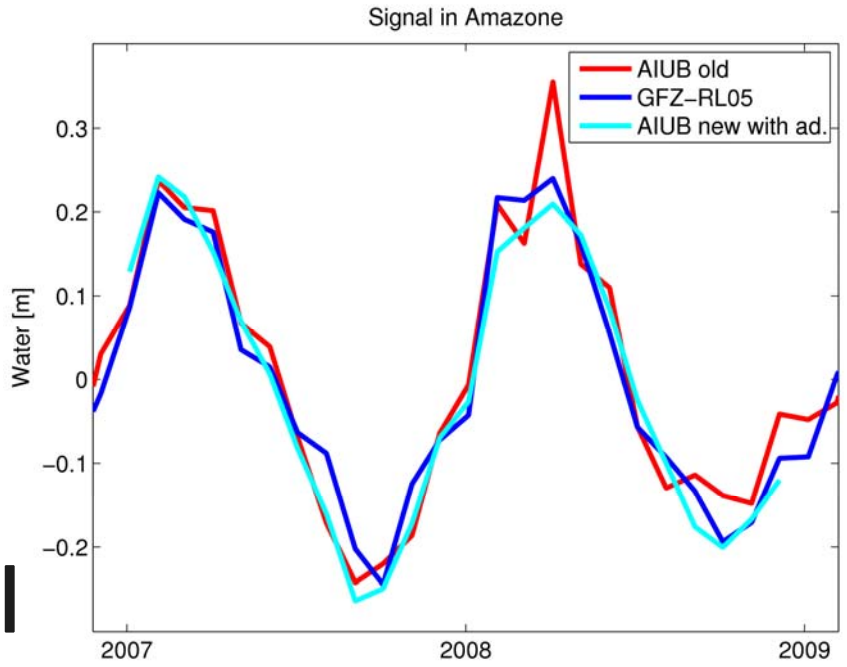

signal

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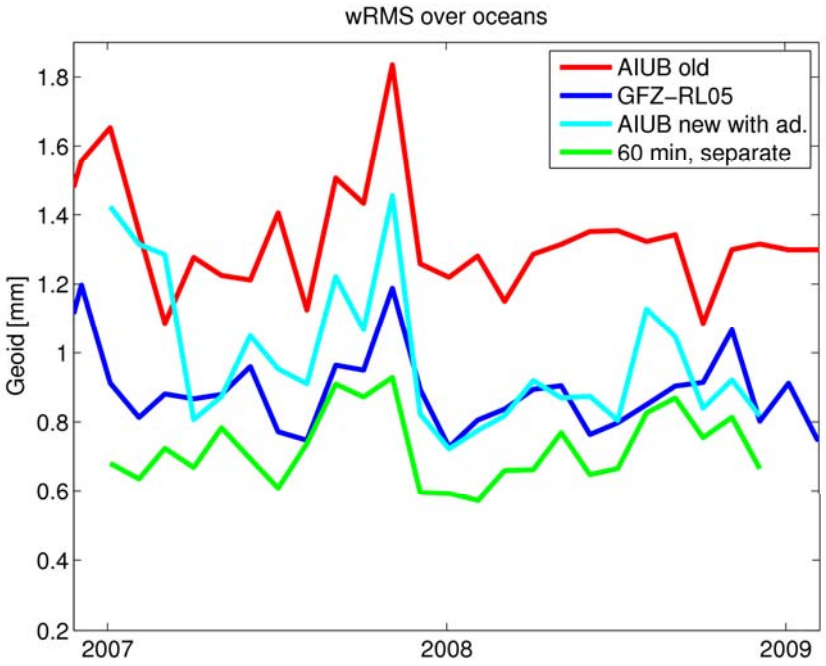

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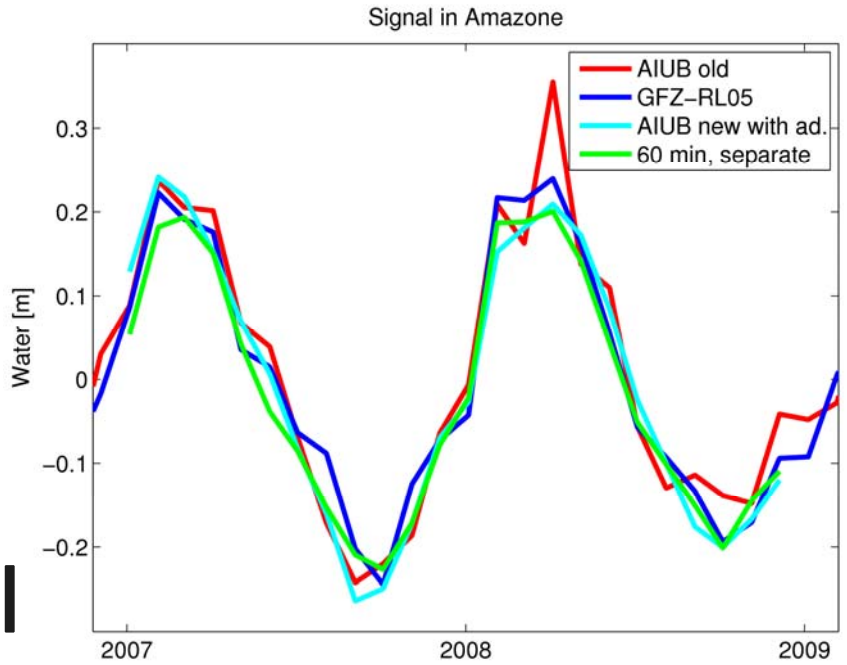

signal

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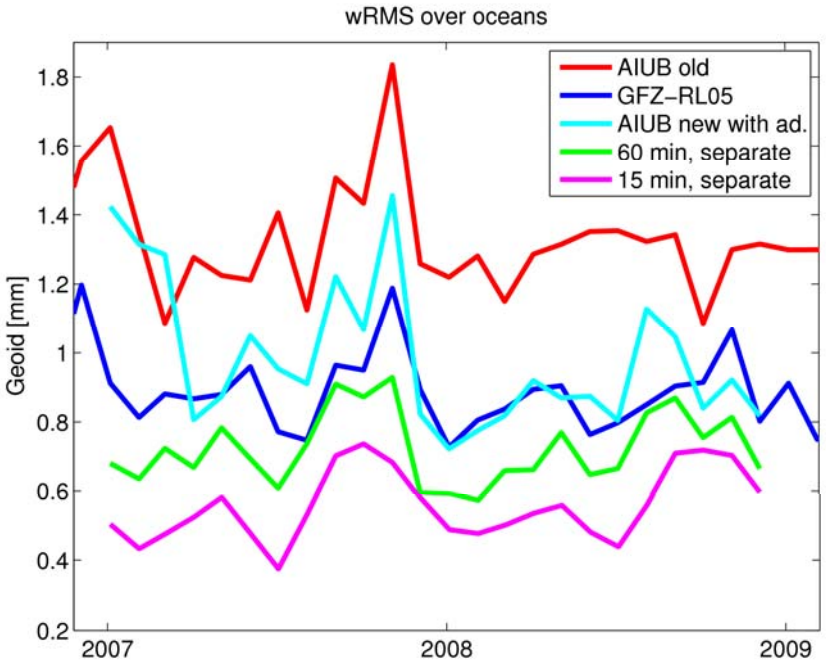
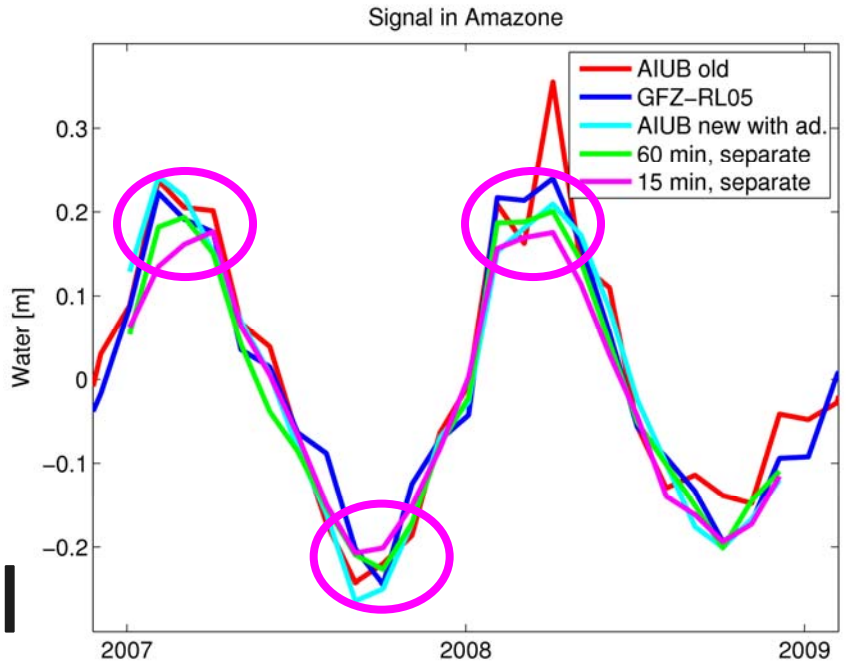


noise

signal loss



signal

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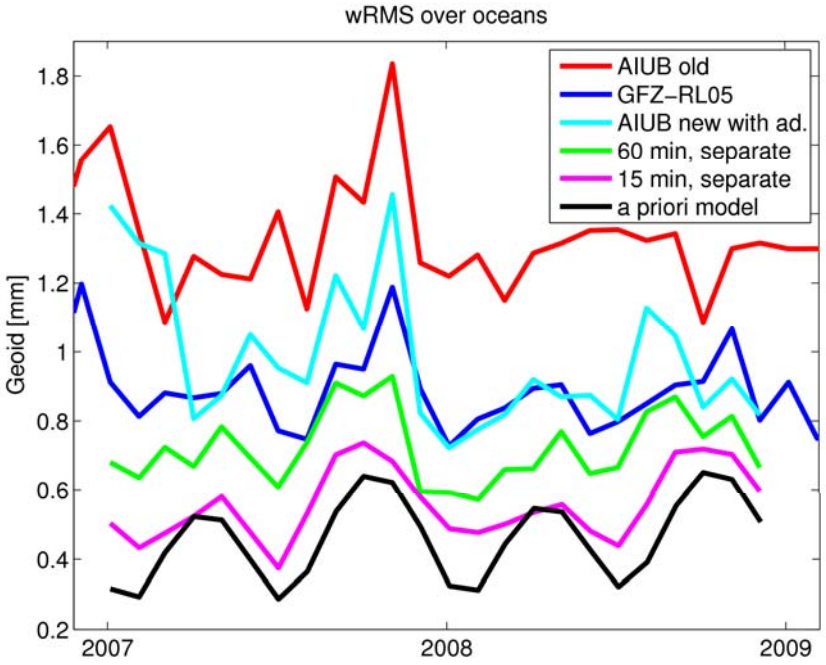

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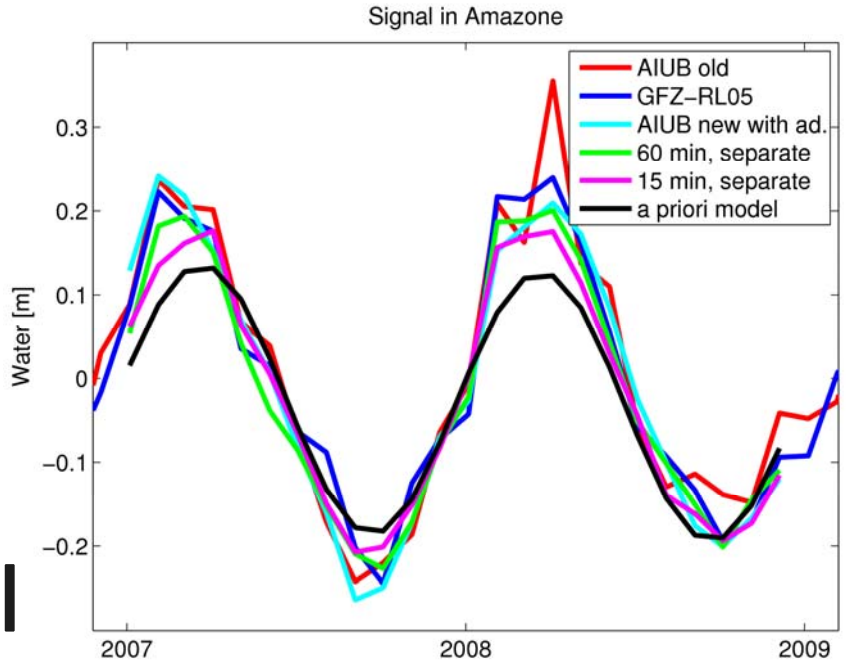
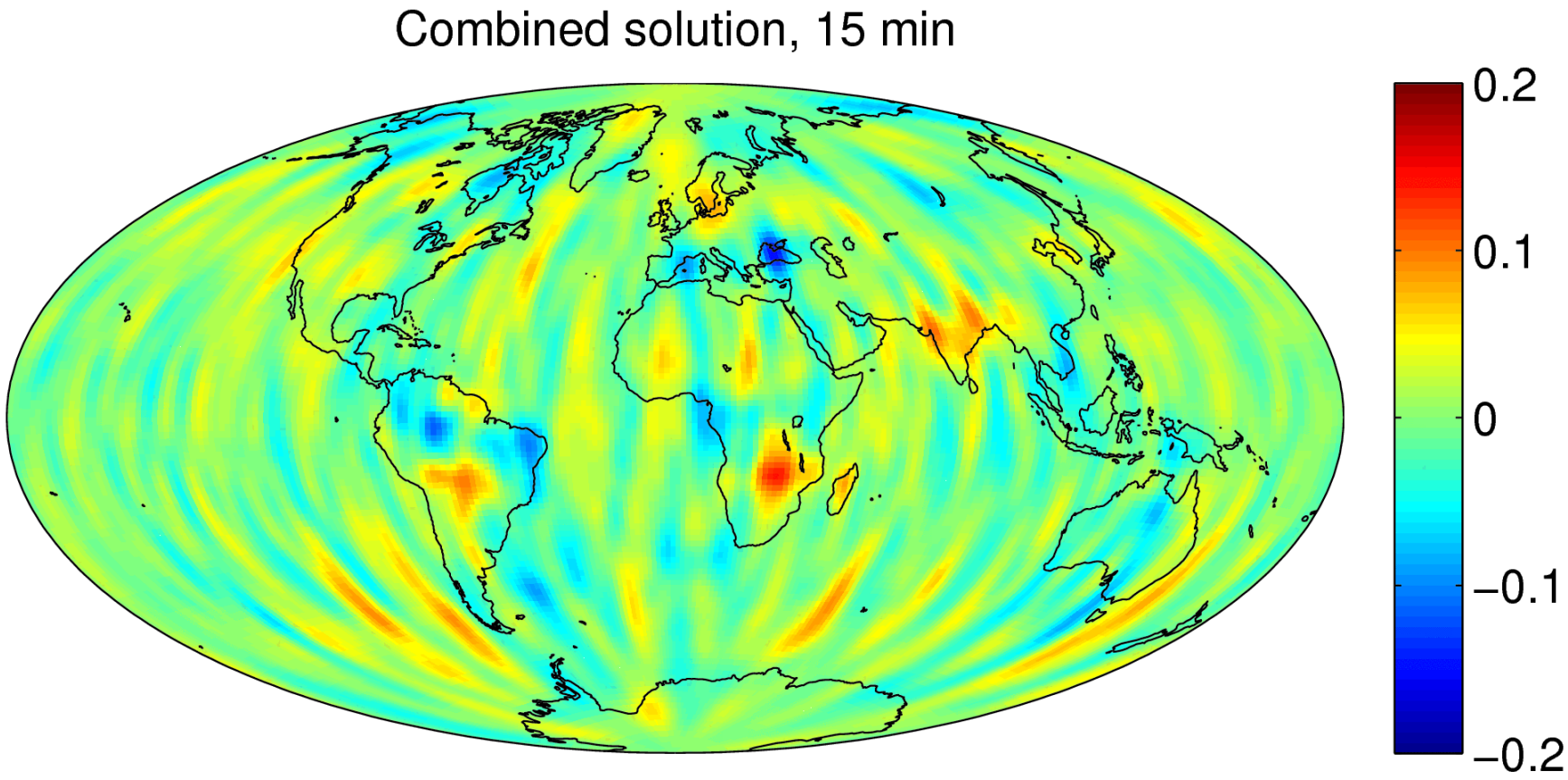


signal

Monthly field – a priori model



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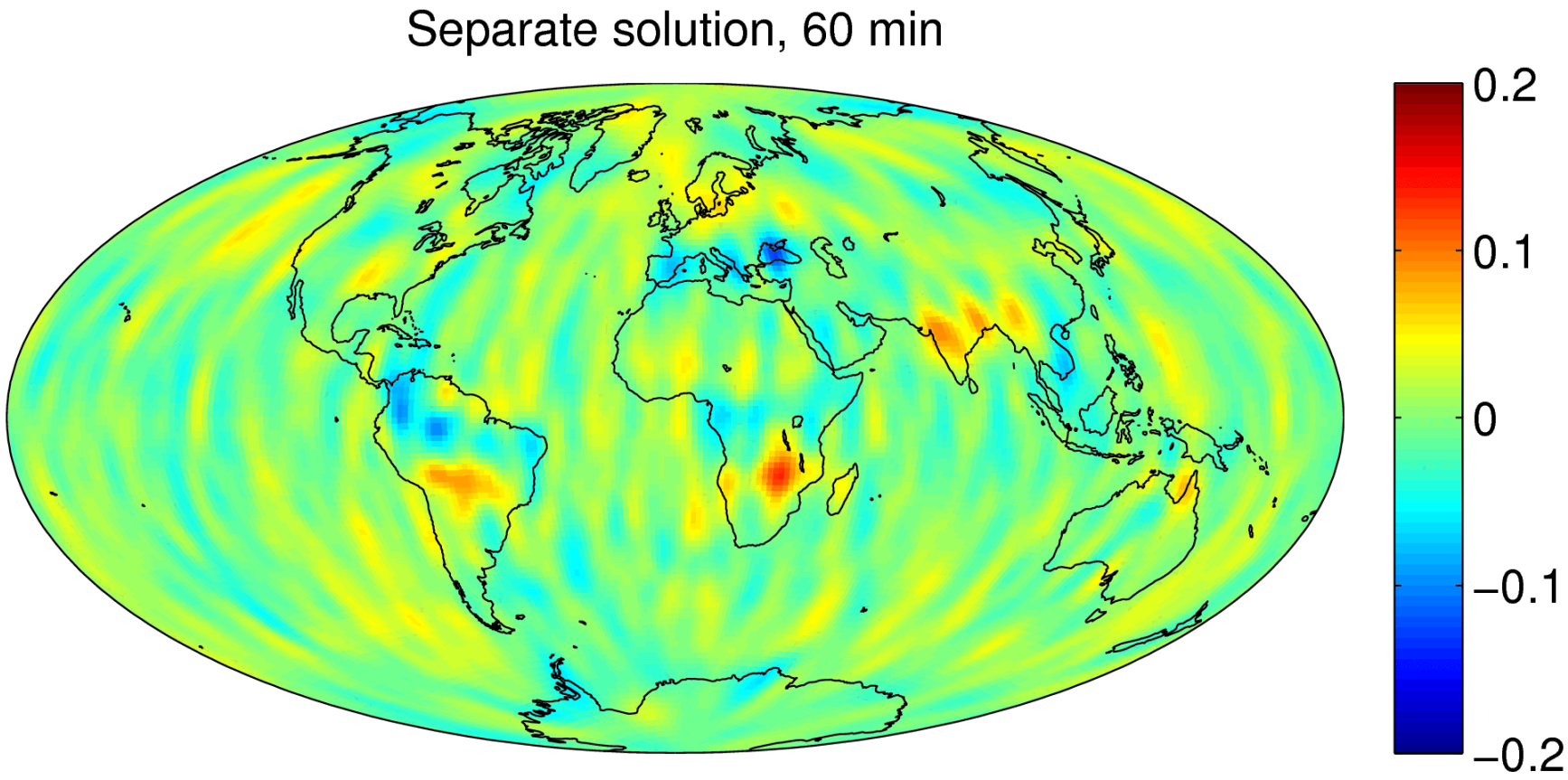
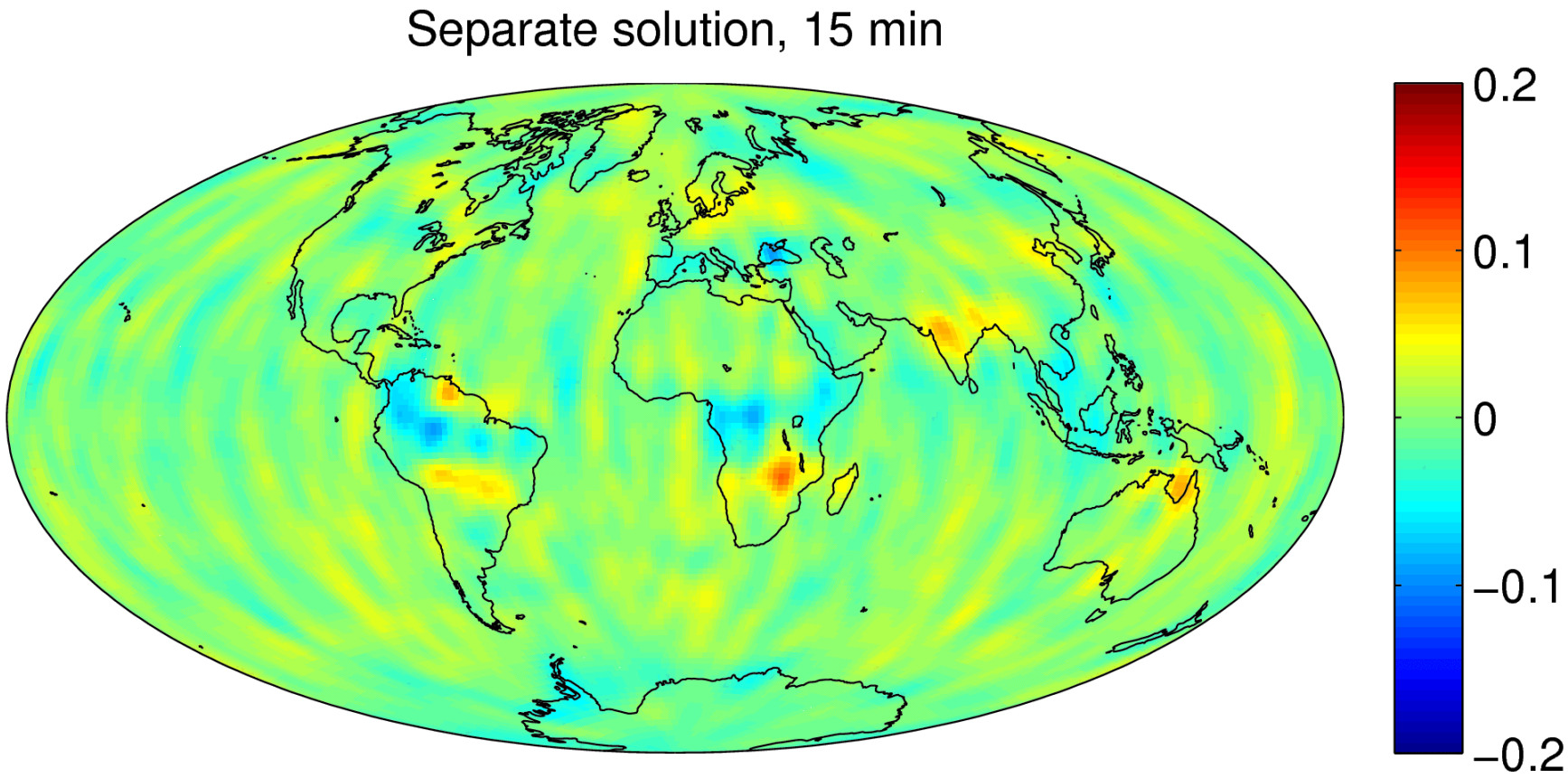
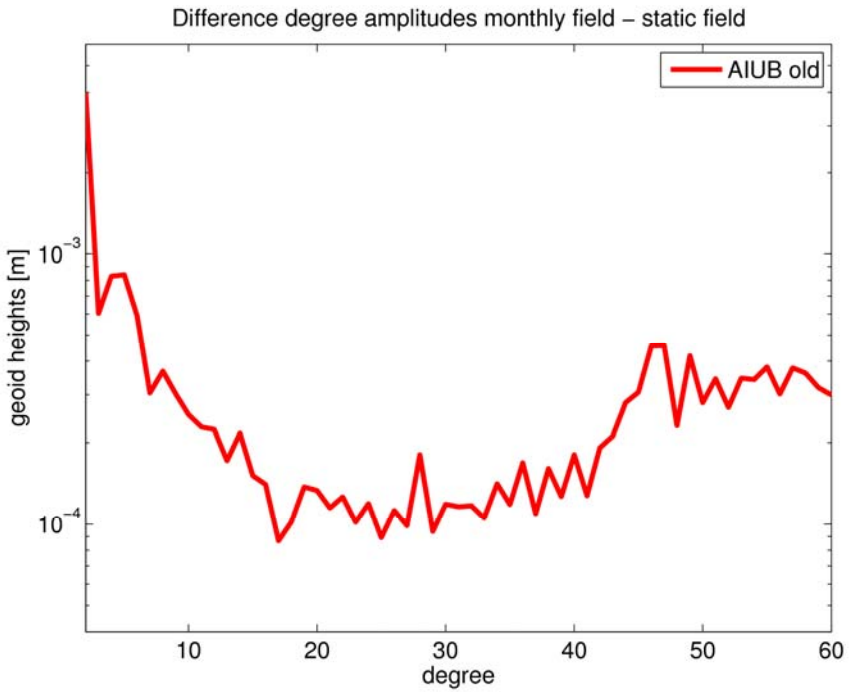


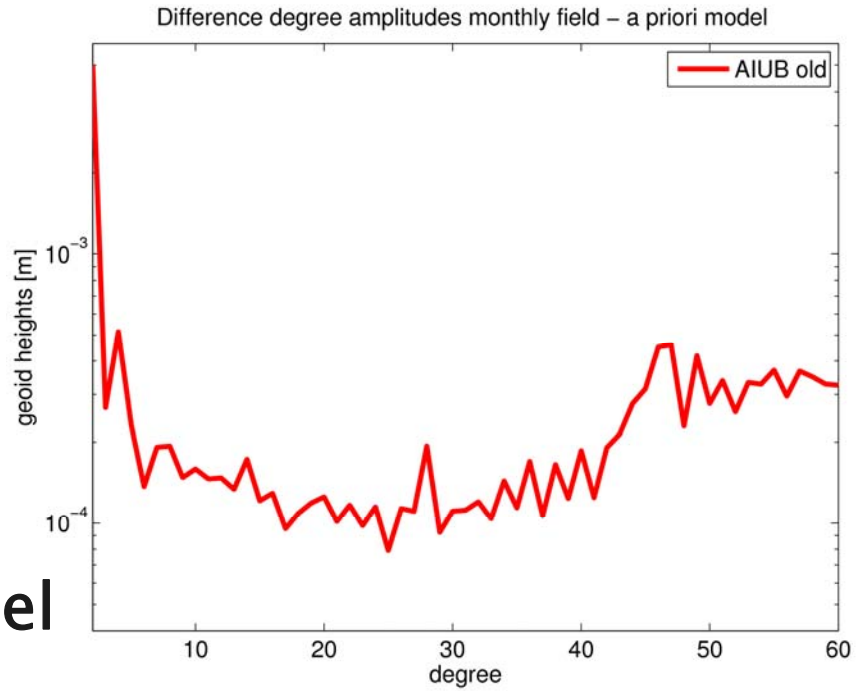
Monthly field – a priori model



Degree Variances (monthly field)

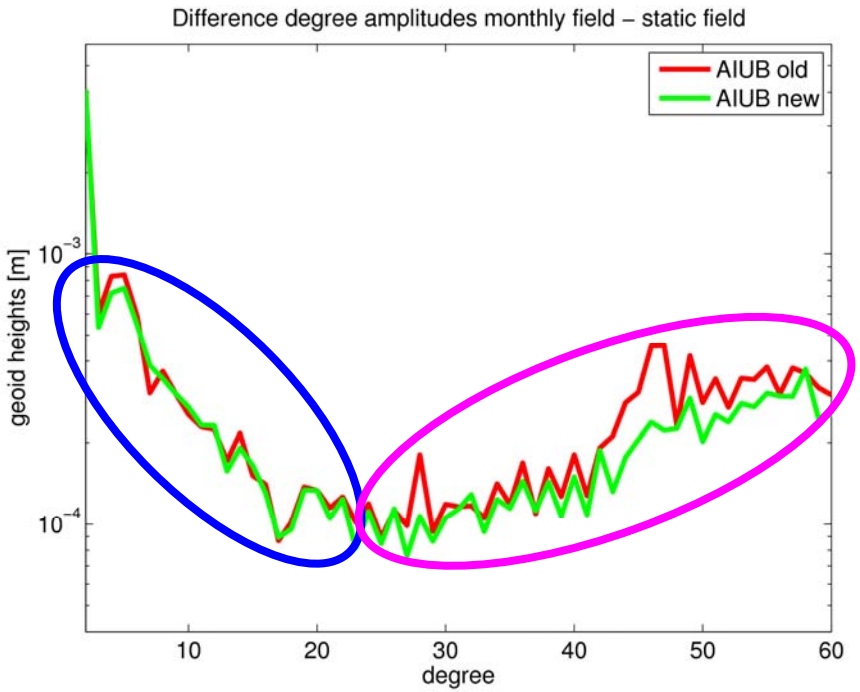


monthly field – static field



monthly field – timevar. model

Degree Variances (monthly field)

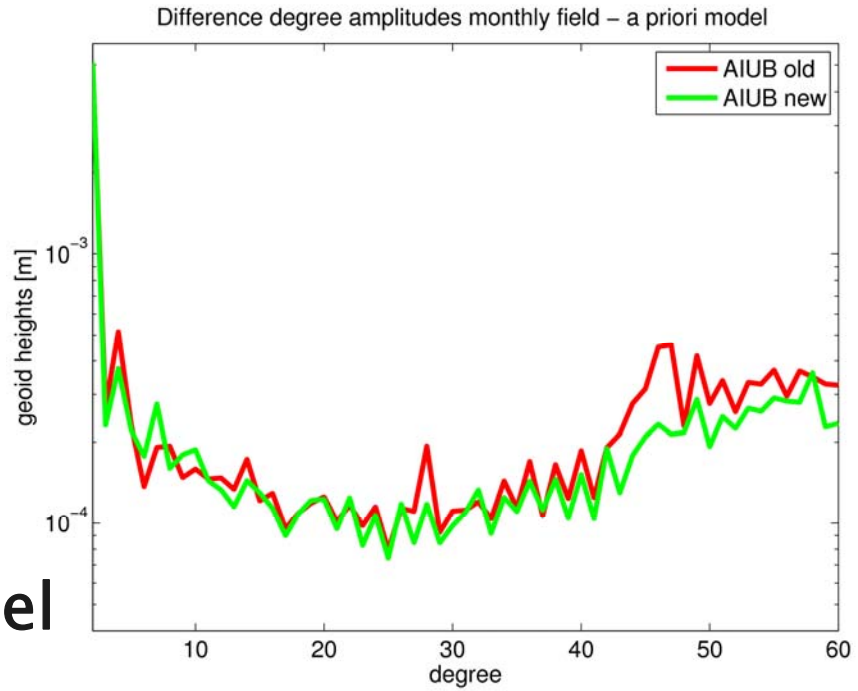


monthly field – static field

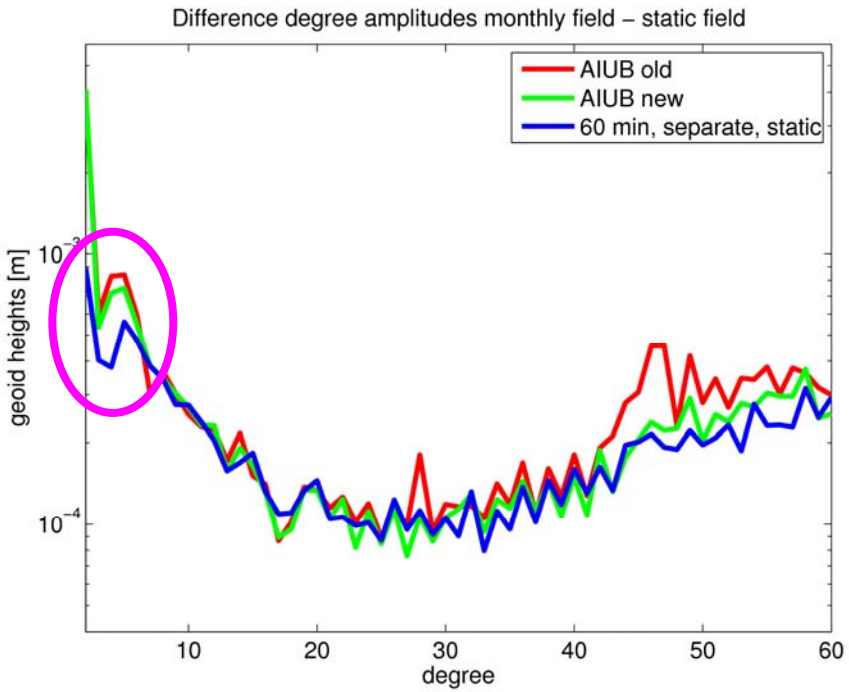
signal-dominated

noise-dominated

monthly field – timevar. model

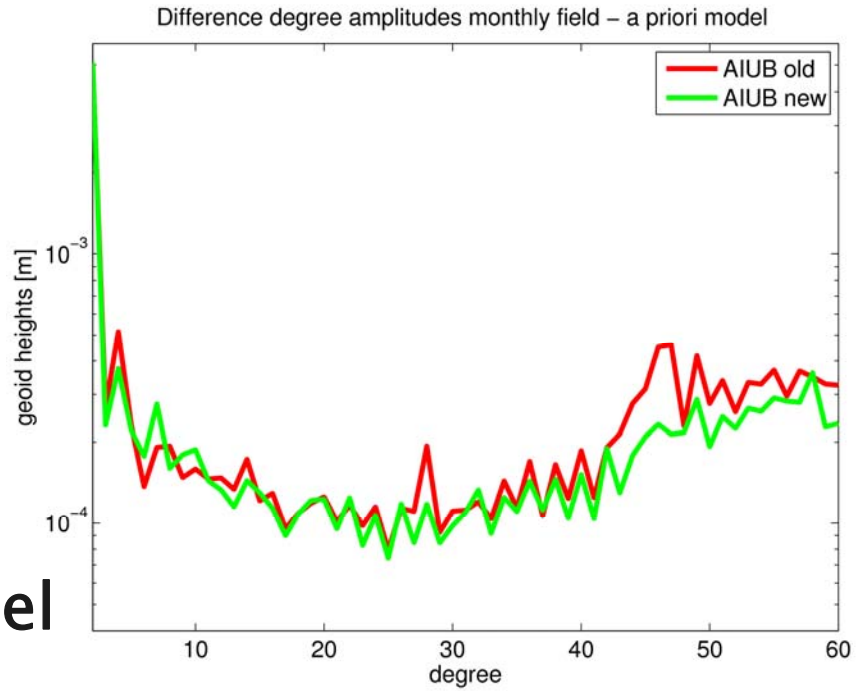


Degree Variances (monthly field)



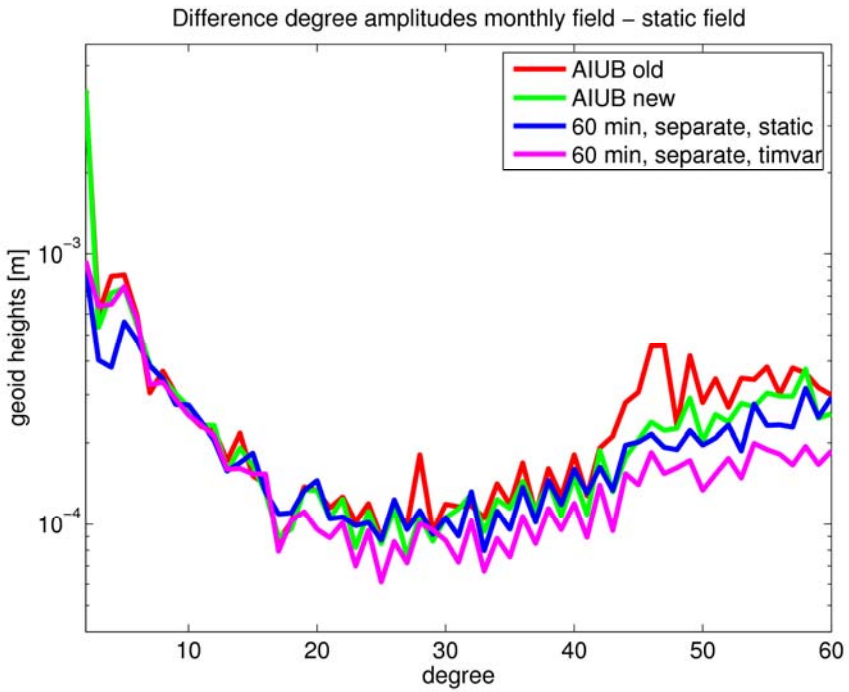
monthly field – static field

signal damaged



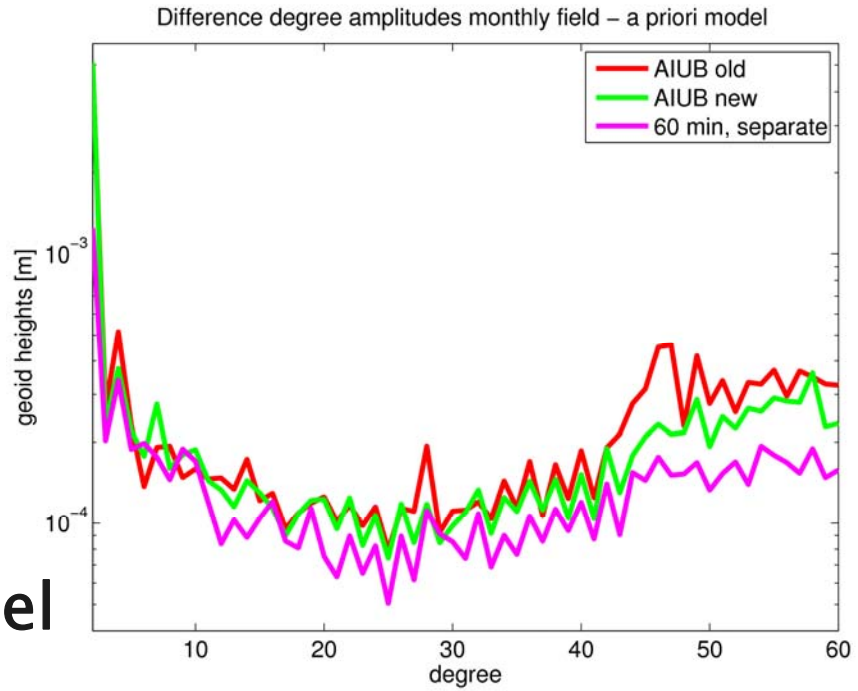
monthly field – timevar. model

Degree Variances (monthly field)



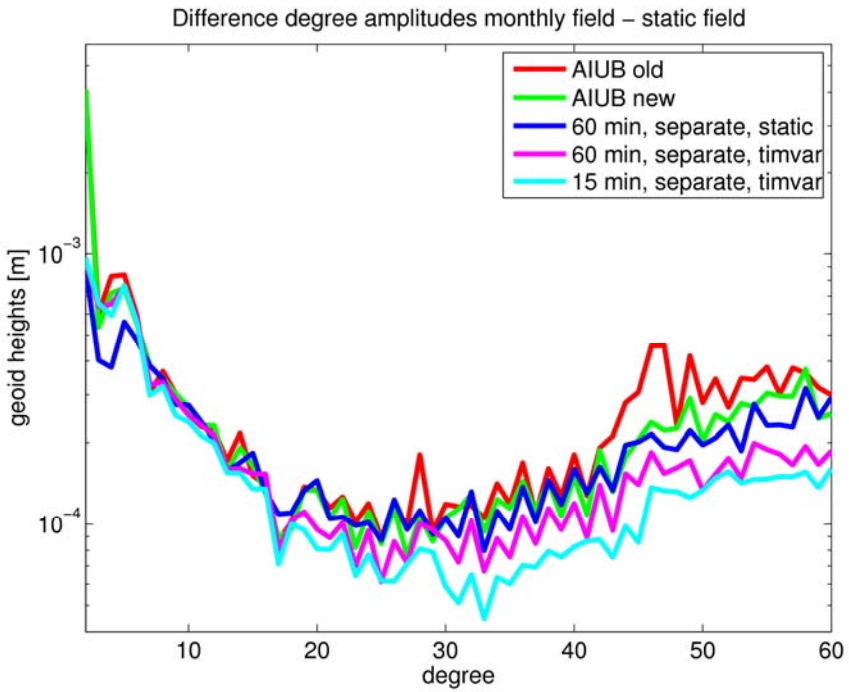
monthly field – static field

all degrees influenced



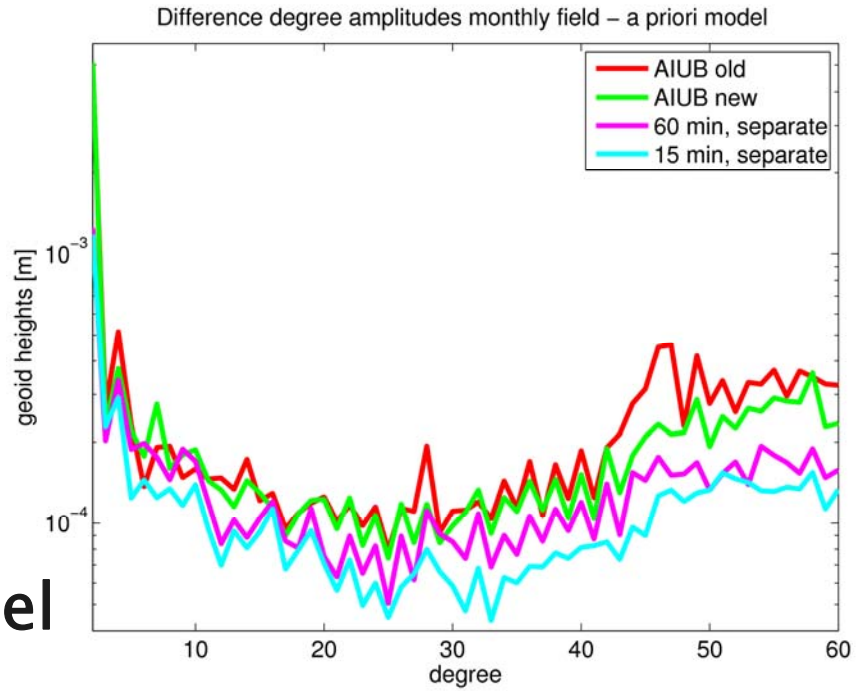
monthly field – timevar. model

Degree Variances (monthly field)



monthly field – static field

signal is dampened



monthly field – timevar. model

How does it work?

How do we influence spherical harmonics of all degrees by only a few low frequent stochastic parameters?

High pass filter of Lumped Coefficients of orbit perturbations.

What happens if we estimate arc specific orbit parameters and gravity field coefficients separately?

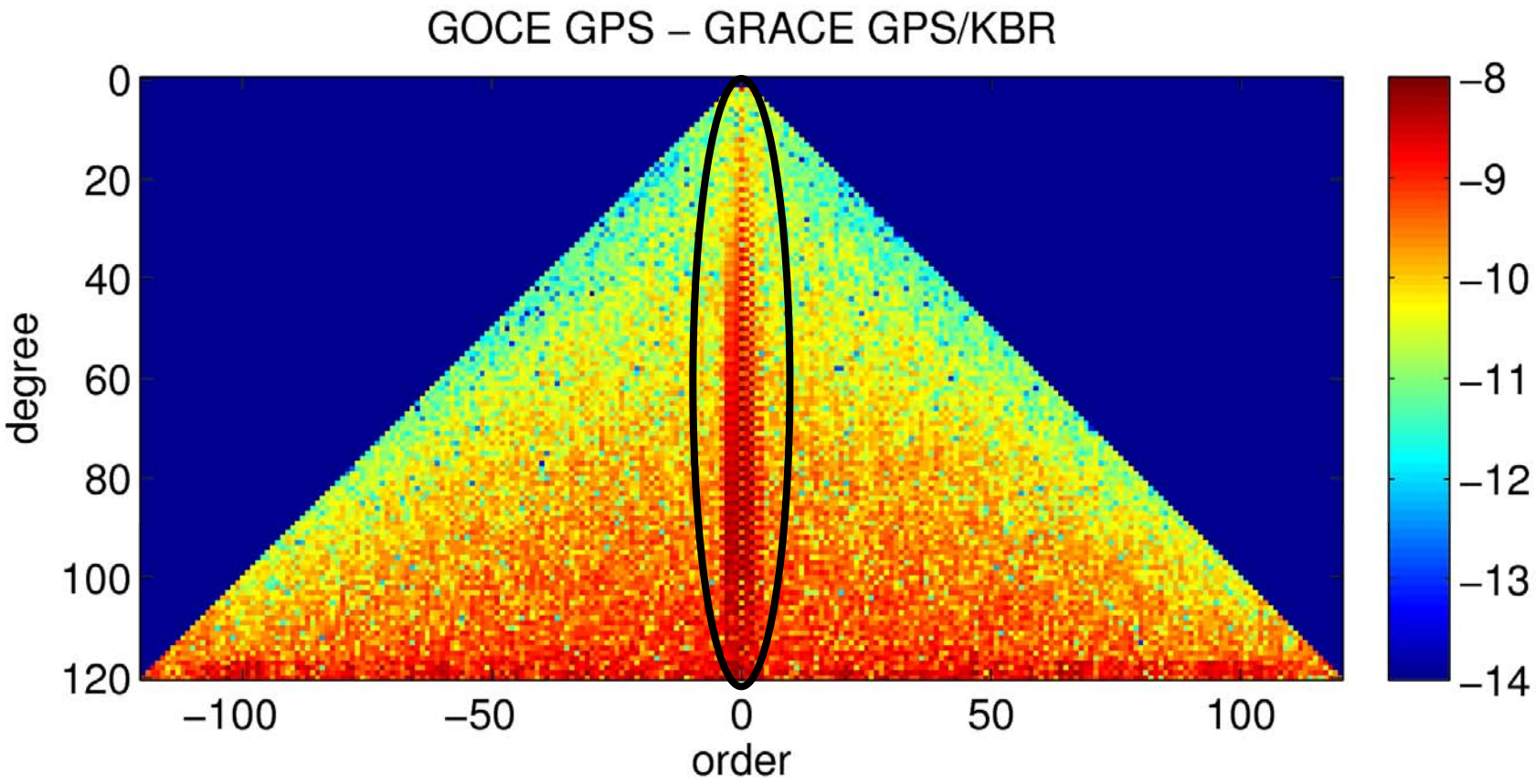
Correlations are destroyed, signal in stochastic parameters is lost for gravity field coefficients.

Discussion

Is it good or bad?

- Is it correct?
  - Not really
- Is it helpful?
  - Yes
- Is it dangerous?
  - Yes

GOCE polar gap



polar gap

GOCE polar gap